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Editorial

Radar and Sonar Sensor Networks

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Although radar and sonar rely on two fundamentally different types of wave transmission, Radio Detection and Ranging (RADAR) and Sound Navigation and Ranging (SONAR) both are remote sensing systems with important military, scientific, and commercial applications. RADAR sends out electromagnetic waves, while active SONAR transmits acoustic (i.e., sound) waves. In both systems, these waves return echoes from certain features or targets that allow the determination of important properties and attributes of the target (i.e., shape, size, speed, distance, etc.). Because electromagnetic waves are strongly attenuated (diminished) in water, RADAR signals are mostly used for ground or atmospheric observations. Because SONAR signals easily penetrate water, they are ideal for navigation and measurement under water. The networking of radars and networking of sonars are two emerging research areas, known as radar sensor networks and underwater sensor networks.

This special issue contains eleven papers selected from submissions through open calls. These papers highlight some of the current research interests and achievements in the area of radar sensor network and underwater sensor networks. The topics include UWB radar sensor networks, MAC protocol design, network routing, target detection, propagation modeling, and interference mitigation.

Q. Ren and X. Cheng's paper presents a proposed MAC protocol that is latency-optimized and energy-efficient scheme and combines the physical layer and the MAC layer to shorten transmission delay. On physical layer, convolution coding and interleaver are used for transmitted information. Moreover, dynamic code rate is exploited at the receiver side to accelerate data reception rate. On MAC layer, unfixed frame length scheme is applied to reduce transmission delay, and to ensure the data successful transmission rate at the same time.

J. Liang et al.'s paper presents that foliage clutter should be more accurately described by a log-logistic model based on UWB radar. Two different datasets by means of maximum likelihood (ML) parameter estimation as well as the root mean square error (RMSE) performance are analyzed. It shows that the log-logistic model achieves the smallest standard deviation (STD) error in parameter estimation as well as the best goodness-of-fit and smallest RMSE for both poor and good foliage clutter signals.

Q. Ren's paper presents energy detection performance analysis for UWB radar sensor networks. Considering hidden terminal and exposed node problems, a theoretical analysis on the performance of commonly used energy detection methods, such as ideal method, transmitter-independent method, and transmitter/receiver-cooperated method, is analyzed in terms of detection probability. Corresponding analytical models are provided. Performance theoretical curves are acquired to compare the characteristics for individual energy detection methods under various scenarios.

T. Jiang et al.'s paper optimizes the cluster structure to solve problems such as the uneven energy consumption of the radar sensor nodes and random cluster head selection in the traditional clustering routing algorithm. According to the defined cost function for clusters, a clustering algorithm

is proposed based on radio-free space path loss. In addition, the energy and distance pheromones based on the residual energy and aggregation of the radar sensor nodes are presented. According to bionic heuristic algorithm, a new ant colony-based clustering algorithm for radar sensor networks is also proposed.

P. Xie et al.'s paper tackles one fundamental problem in underwater sensor networks: robust, scalable, and energy efficient routing. Vector-based forwarding (VBF), a geographic routing protocol is proposed. In VBF, the forwarding path is guided by a vector from the source to the target, no state information is required on the sensor nodes, and only a small fraction of the nodes is involved in routing. To improve the robustness, packets are forwarded in redundant and interleaved paths. Further, a localized and distributed self-adaptation algorithm allows the nodes to reduce energy consumption by discarding redundant packets.

B. Li et al.'s paper considers interference mitigation in UWB sensors in the context of cognitive radio (CR). Firstly, a general state transition model is proposed to characterize the working states evolution of legal networks, also referred to as primary users (PU). Spectrum sensing, used to identify the state of PU, is formulated as detection of a corresponding state sequence. Maximum posterior probability (MAP) criterion is adopted to perform spectrum sensing. By exploring potential gain of state transitions, detection probability for nearby networks is improved significantly.

B. Cao et al.'s paper analyzes the interferences by exploring the polarization information of the electromagnetic (EM) waves. Then, the oblique projection polarization filtering- (OPPF-) based scheme is proposed to suppress the interferences while keeping the amplitude and phase of its own return in RSNs, even if the polarized states of the radar members are not orthogonal. The proposed method uses all radar members' polarization information to establish the corresponding filtering operator.

L. Xu and Q. Liang's paper presents the definitions and properties of a set of new ternary codes, ZCZ sequence Pair Set (ZCZPS), and proposes a method to use the optimized punctured sequence-pair along with Hadamard matrix to construct an optimized punctured ZCZ sequence-pair set (OPZCZPS) which has ideal autocorrelation and cross-correlation properties in the zero correlation zone. Considering the moving target radar system, the correlation properties of the codes will not be severely affected when Doppler shift is not large.

L. Zhang et al.'s paper initiatively puts forward a novel synthesis design for generating UWB narrow pulse by using CI (Carrier Interference) subcarrier waveform synthesis and Bessel function expansion. Through adaptively adjusting the initial phases of multiple subcarriers according to the location information, CI (Carrier Interference) subcarrier waveform synthesis signal could achieve better performance.

W. Li et al.'s paper presents a new algorithm called Signal Subspace Extraction (SSE) for detecting and estimating target echoes in reverberation. The new algorithm can be taken as an extension of the Principal Component Inverse (PCI) and maintains the benefit of PCI algorithm and moreover shows better performance due to a more reasonable reverberation model. In the SSE approach, a best low-rank estimate of a target echo is extracted by decomposing the returns into short duration subintervals and by invoking the Eckart-Young theorem twice.

J Rovnakova and D. Kocur's paper studies through wall tracking of moving targets. All phases for through wall tracking are outlined whereas the attention is devoted to the estimation of the correct input data for the localization phase. This is done by applying a new approach that combines the time of arrival (TOA) estimation and the data-association into a single step. The properties of the proposed algorithm are illustrated by processing of real radar signals.

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